Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat (CSAS)

Research Document 2015/047

Maritimes Region

Stock Status Update and Precautionary Approach Limit Points for Atlantic Cod (*Gadus morhua*) in NAFO Subdivision 4Vn (May-October)

M.A. Showell

Fisheries and Oceans Canada
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, Nova Scotia
Canada B2Y 4A2

August 2015

Canada

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

© Her Majesty the Queen in Right of Canada, 2015
ISSN 1919-5044

Correct citation for this publication:

Showell, M.A. 2015. Stock Status Update and Precautionary Approach Limit Points for Atlantic Cod (*Gadus morhua*) in NAFO Subdivision 4Vn (May-October). DFO Can. Sci. Advis. Sec. Res. Doc. 2015/047: iv + 12 p.

TABLE OF CONTENTS

ABSTRACT iv
RÉSUMÉ iv
BACKGROUND 1
INTRODUCTION 1
THE FISHERY 2
ABUNDANCE, AREA OF OCCUPANCY, MORTALITY AND RECRUITMENT 2
REFERENCE POINTS 3
REFERENCES CITED 3
FIGURES 4

ABSTRACT

The objective of this research document is to provide information on the Atlantic cod stock in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 4Vn (May-October) in support of the Recovery Potential Assessment for the Atlantic cod Laurentian South Designatable Unit. The information was used in the science peer review meeting of December 6 to 8, 2010 to define reference points for Atlantic cod in the Fisheries and Oceans Canada (DFO) Gulf and DFO Maritimes regions as well as the science peer review meeting of the Recovery Potential Assessment of Atlantic cod held February 21-25, 2011. Historical catches and survey indices are described, as well as other indicators of stock productivity. A limit reference point corresponding to a spawning stock biomass reference point of $B_{recover}$ is also defined for this stock.

Mise à jour sur l'état du stock et points limites de l'approche de précaution concernant la morue franche (Gadus morhua) dans la sous-division 4Vn de l'OPANO (de mai à octobre)

RÉSUMÉ

L'objectif de ce document de recherche est de fournir des renseignements sur le stock de morue franche dans la sous-division 4Vn de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO) (de mai à octobre) afin d'appuyer l'évaluation du potentiel de rétablissement de la morue franche dans l'unité désignable du Sud laurentien. Les renseignements ont été utilisés dans le cadre de la réunion d'examen scientifique par les pairs du 6 au 8 décembre 2010 afin de définir des points de référence pour la morue franche dans les régions du Golfe et des Maritimes du MPO ainsi que dans le cadre de la réunion d'examen scientifique par les pairs de l'évaluation du potentiel de rétablissement de la morue franche qui a eu lieu du 21 au 25 février 2011. Les prises historiques et les indices de relevé sont décrits ainsi que d'autres indicateurs de la productivité du stock. Un point de référence limite correspondant à un point de référence de la biomasse du stock reproducteur de Brecover est également défini pour ce stock.

BACKGROUND

The Committee on Status of Endangered Wildlife in Canada (COSEWIC) assessed as Endangered four Designatable Units (DU) of Atlantic Cod in eastern Canada, including the Laurentian South DU (stocks in Northwest Atlantic Fisheries Organization (NAFO) Subdivisions 4TVn, 4Vn (resident), and 4VsW) and the Southern Canada DU (stocks in NAFO Subdivisions 4X5Y and 5Zjm) (COSEWIC 2010). To support the analyses to be conducted in the Recovery Potential Assessment (RPA) of the Laurentian South and the Southern Canada DUs, two science peer review meetings were conducted. The first meeting was held December 6 to 8, 2010 to address questions related to assessment models, medium-term projections, and reference points (DFO 2011a). The second meeting was the RPA, held February 21-25, 2011 (DFO 2012).

Recovery Potential Assessments were introduced by Fisheries and Oceans Canada (DFO) Science to provide the information and scientific advice necessary to meet various requirements of the *Species at Risk Act* (SARA), including decisions regarding the listing of a species under the *Act* and the development of a Recovery Strategy. Specifically, as part of the assessment process, scientific information is needed to support the development of social and economic cost assessment scenarios for recovery. This information will better inform public consultations, and support other entities involved in the decision of whether or not to add the species to Schedule 1 of SARA. The recovery team also requires this information to develop a Recovery Strategy, and if necessary, one or more Action Plans.

The objective of this research document is to address aspects related to the terms of reference for the Atlantic Cod RPA from those two meetings as it relates to the Sydney Bight resident Cod stock (NAFO Subdivision 4Vn (May-October), Figure 1).

INTRODUCTION

In its 2010 assessment of Atlantic Cod, COSEWIC designated the Laurentian South Designatable Unit (DU) as Endangered due to a 90% decline in abundance of mature individuals over the previous three generations (COSEWIC 2010). The Laurentian South DU consists of three populations or stocks: southern Gulf of St. Lawrence cod (management unit 4T and 4Vn (November-April)), 4Vn resident cod (4Vn (May-October)), and eastern Scotian Shelf cod (4VsW).

There is substantial mixing of the 4Vn (May-October) stock with other components of the Laurentian South DU. The 4Vn resident stock is present in the Sydney Bight area from May to October, but migrates offshore in winter where it mixes with the Southern Gulf (4T) stock (Lambert and Wilson 1994). Based on ichthyoplankton surveys and observations from the DFO summer RV survey, 4Vn cod are known to spawn to the west of Sydney Bight in late-spring and early-summer. However, based on the distribution of spawning aggregations, vertebral counts, tagging studies and parasite distribution, the 4Vn May-October stock (4Vn resident) is thought to be a distinct population, separate from the Southern Gulf component. Similarly, after the spawning period in summer, the resident stock mixes with eastern Scotian Shelf component of the DU.

The 4Vn resident stock is by far the smallest component of the DU, comprising only 3-4% of the total biomass in the DU (DFO 2011b). Despite its small size, the 4Vn resident does seem to be a distinct component and is important in that respect.

THE FISHERY

Cod landings in NAFO Subdivision 4Vn declined sharply from the mid-1980s to 1992, when catch quotas restricted the fishery. After 1989, the catch was substantially less than the Total Allowable Catch (TAC). In September 1993, the fishery was closed and this moratorium still remains in effect (Figure 2).

ABUNDANCE, AREA OF OCCUPANCY, MORTALITY AND RECRUITMENT

Information for NAFO Subdivision 4Vn (resident) cod is available from two surveys:

- the summer DFO summer RV survey (1970 to 2010); and
- a collaborative DFO-Industry fixed gear survey (1994 to present).

The sampling intensity in NAFO Subdivision 4Vn for the DFO summer RV survey is very low (12-15 sets per year), which results in high variability in estimates. As a consequence, year classes are difficult to track. The DFO summer RV survey results were highest from 1980 to 1990, but total numbers and weights have subsequently declined to low levels (Figure 3). Broken down by age, an increase in age 1+ numbers and biomass was seen in 2001 and 2002, but this has not resulted in an increase in spawning stock biomass (SSB) (Figure 4). Although a shorter time series, the DFO-Industry fixed gear survey conducted in October has a much higher sampling intensity. Catch rates in this survey have shown a decline similar to that of the DFO summer RV survey, and are now at the lowest observed levels (Figure 5).

Trends in Design Weighted Area of Occupancy (DWAO) for Atlantic cod within NAFO Subdivision 4Vn (May-October) were examined based on the DFO summer RV survey data from 1970-2010 (Figure 6). Area of occupancy for NAFO Subdivision 4Vn cod (Figure 6) is quite variable, but did not show any distinct trends for small (≤ 38 cm) fish. However, a declining trend was observed for large (> 38 cm) fish starting in 1990, with the index falling by about one-third.

Estimates of total mortality (Z) were calculated from the DFO summer RV survey data by age group. Although variable (even with smoothing), Z increased in the mid-1980s for older ages. Z for younger fish increased from the early 1990s onwards, and is currently in the same range as the older fish (Figure 7).

Relative fishing mortality (F) is calculated from total biomass from the DFO summer RV survey and landings data (Figure 8). Based on this, exploitation was seen to be high in the early to mid-1970s and again from 1987 to 1991. Exploitation was generally low following the closure of the fishery in 1994, although the 2004 point appears anomalous. With the cessation of the DFO-Industry fixed gear survey commercial index in 2007, relative F has dropped to a very low level.

Figure 9a shows a recruitment index (sum of age 2-4 fish) from the DFO summer RV survey. While considerable variation is seen, recruitment was highest in the early part of the time series, but generally declined from 1988 onwards. The estimate for 2002 was high, but this strong signal did not translate into a subsequent increase in biomass.

An index of recruits per SSB (recruitment rate) is presented in Figure 9b. While the index was relatively low for the early part of the time series, since 1998 it has been sharply higher, indicating that recruitment has been relatively high given the low SSB during this recent period.

Condition (predicted weight at length) for both large (50 cm) and small (30 cm) fish was highest in the 1970s, but declined subsequently (Figure 10). While considerable variability is seen in the time series, condition for large cod has been without trend since 1980, while condition of 30 cm cod has shown a decline.

Length at age was also calculated from DFO summer RV survey observations (Figure 11). Length at age for older (ages 4-7) fish was highest from the mid-1970s, but subsequently

declined. Some improvement has been seen in recent years. Length at age for younger (ages 2 and 3) shows little trend over the time series.

Survey total mortality is currently high despite relative F decreasing and recent catches being very low. Recruitment is generally lower in recent years, and year classes which appear strong do not contribute to an increase in SSB subsequently. Under these circumstances, improvement in stock dynamics is driven by natural mortality. Productivity will remain low until mortality decreases.

REFERENCE POINTS

The NAFO Subdivision 4Vn (resident) cod stock is small and exhibits a high degree of mixing with larger adjacent cod stocks. Sampling intensity in this stock in the DFO summer RV survey is low and, as a result, estimates are highly variable and year classes difficult to track. Due to these factors, analytical assessments in the past have exhibited high Coefficients of Variation (CV) and strong retrospective patterns. There is currently no accepted Virtual Population Analysis (VPA).

A number of candidate SSB reference points were identified at a National Workshop for Reference Points for Gadoids (DFO 2002). $B_{recover}$ was defined as the lowest historical biomass level from which the stock has recovered readily. In situations where an accepted VPA model formulation is not available, this method for defining the limit biomass reference point is appropriate.

The DFO summer RV survey provides estimates of area expanded mature (age 5+) biomass for this stock. Mature biomass was low in the early 1970s to 1978, but recovered to higher levels from 1980 to 1989. Based on this recovery, $B_{recover}$ biomass was calculated as the average from the 1973 to 1978 period, with a mean value about 9,700 t. The value reported in DFO (2011a, and 2011b) of 8,400 t for this similar calculation was for estimates not corrected for vessel effect in the 1973-1978 period. The conclusions of DFO (2011b) on status of the NAFO Subdivision 4Vn resident component and the potential for recovery are unchanged. Currently, mature biomass (2004-2009 average) is about 2,100 t, or approximately 22% of $B_{recover}$ (Figure 12).

REFERENCES CITED

COSEWIC. 2010. Assessment and update status report on the Atlantic Cod (*Gadus morhua*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, On. xiii + 105 p.

DFO. 2002. Proceedings on the national workshop on reference points for gadoids; 5-8 November, 2002. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2002/033.

DFO. 2011a. Proceedings of Gulf and Maritimes zonal science advisory process framework meeting for Atlantic Cod assessment models, medium-term projections, and reference points; 6-8 December 2010. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/051.

DFO. 2011b. Recovery potential assessment for the Laurentian South designatable unit of Atlantic Cod (*Gadus morhua*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/028.

DFO. 2012. Recovery potential assessment for Atlantic Cod (Newfoundland and Labrador, Laurentian North, Laurentian South, Southern Designatable Units), February 21-25, 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/048.

Lambert, T.C. and Wilson, S. 1994. Update on the status of 4Vn cod: 1992 – 1993. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 94/46.

FIGURES

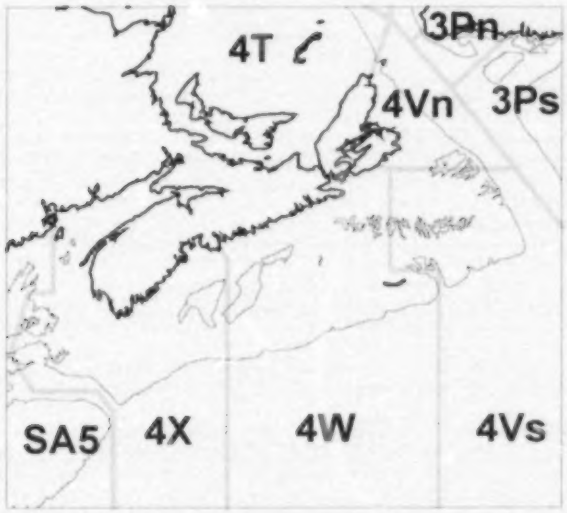

Figure 1. Northwest Atlantic Fisheries Organization (NAFO) Subdivision 4Vn.

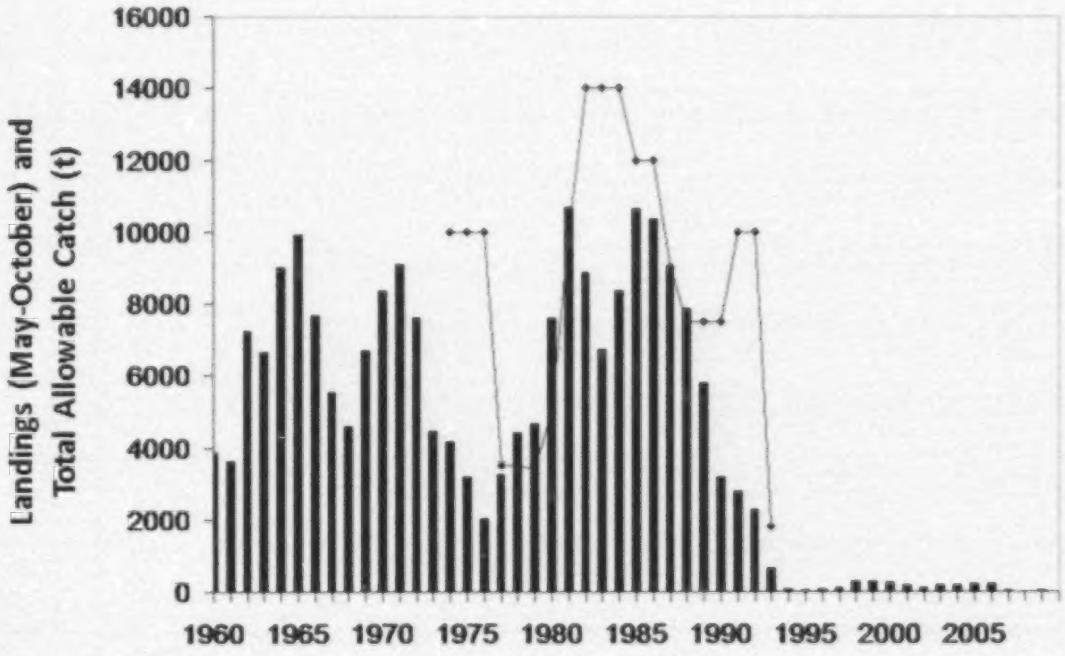

Figure 2. Landings (bars) and Total Allowable Catch (line) in tonnes for 4Vn cod (May-October) 1960 to 2010.

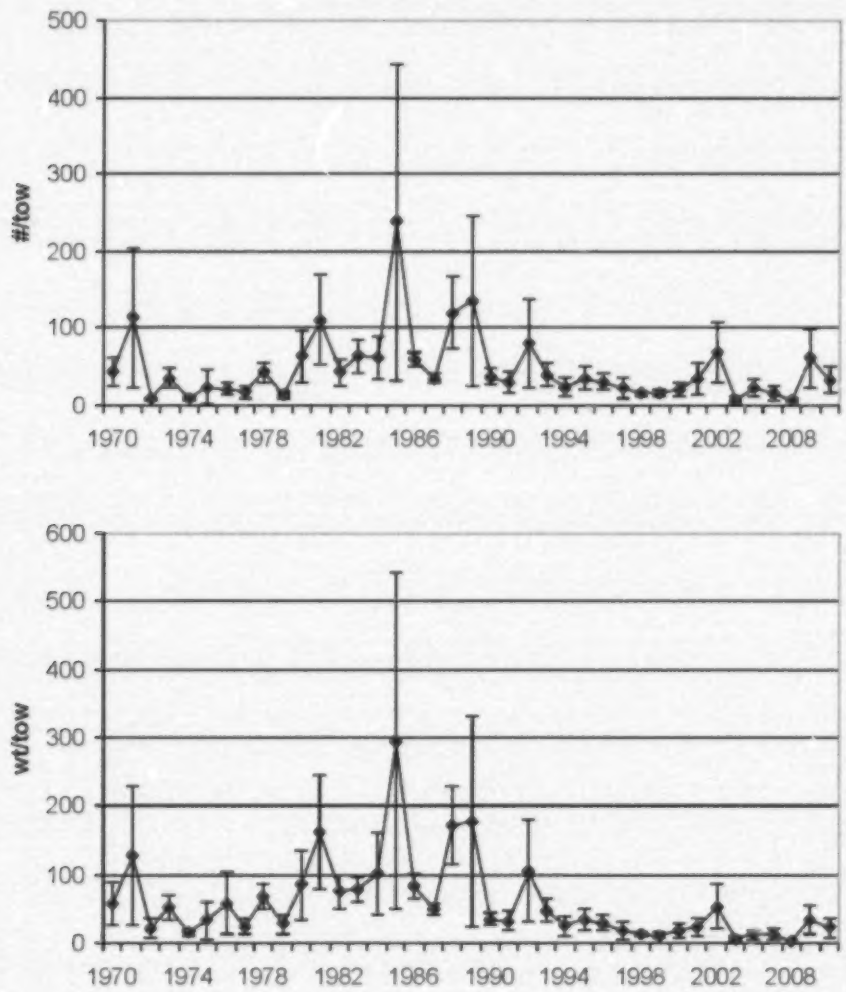

Figure 3. Numbers per tow (upper panel) and weight per tow (kg) (lower panel) for 4Vn cod (May-October) from the DFO summer RV survey.

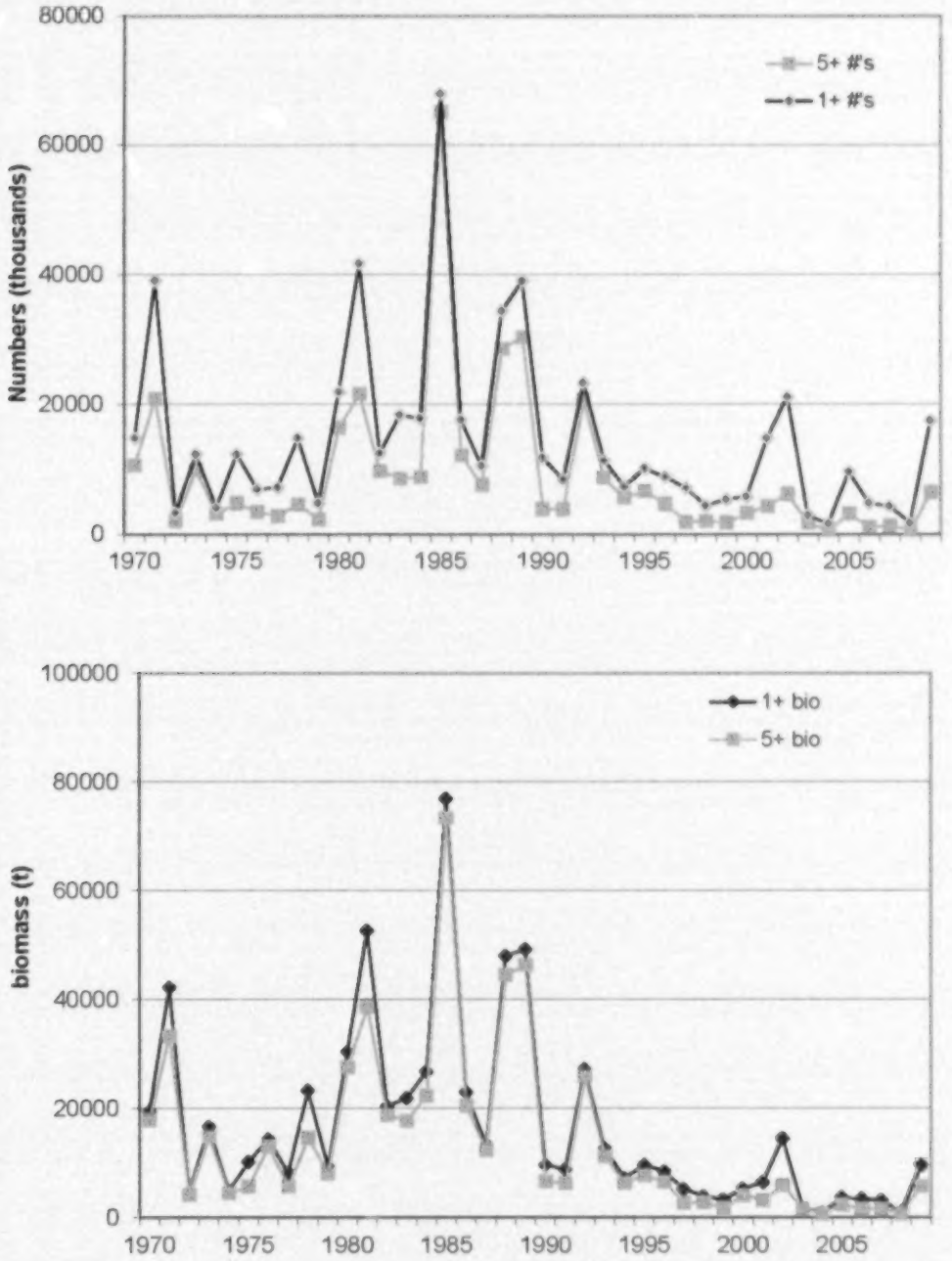

Figure 4. Numbers (upper panel) and biomass (lower panel) for 4Vn cod (May-October) for all ages (age 1+) and mature fish (age 5+) from the DFO summer RV survey.

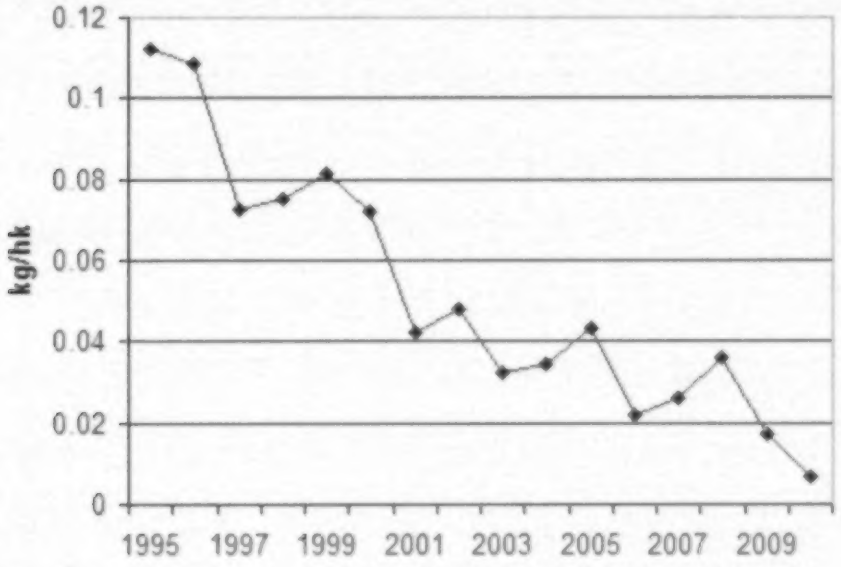

Figure 5. NAFO Subdivision 4Vn cod (May-October) abundance (kg/hook) from the September DFO-Industry fixed gear survey.

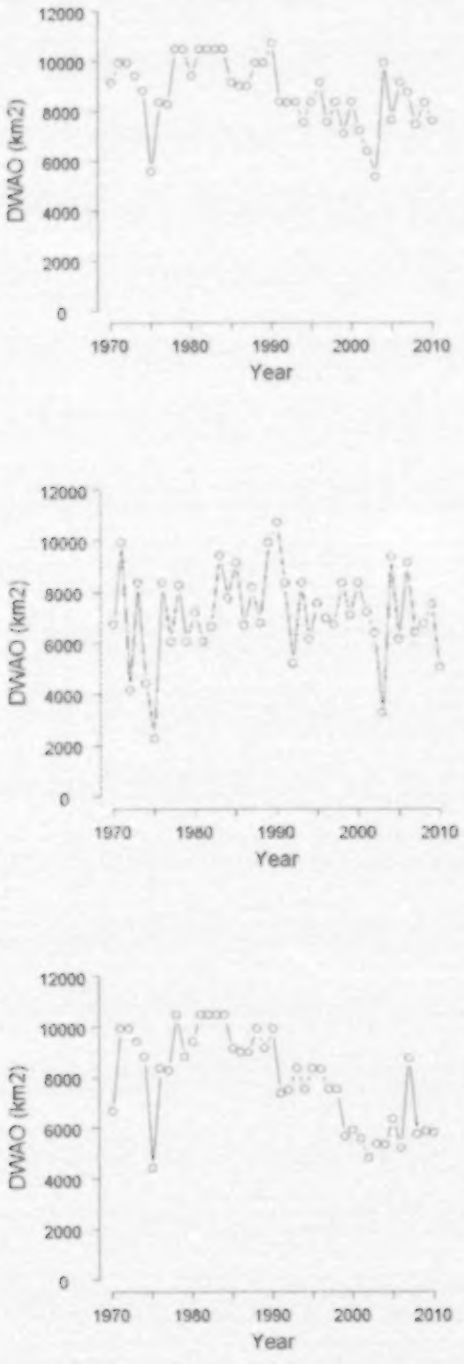

Figure 6. Design weighted area of occupancy (km^2), or DWOA, for 4Vn (May-October) cod all sizes (upper panel), 1-38 cm (middle panel), and greater than 38 cm (lower panel) in NAFO Subdivision 4Vn from the DFO summer RV survey, 1970-2010.

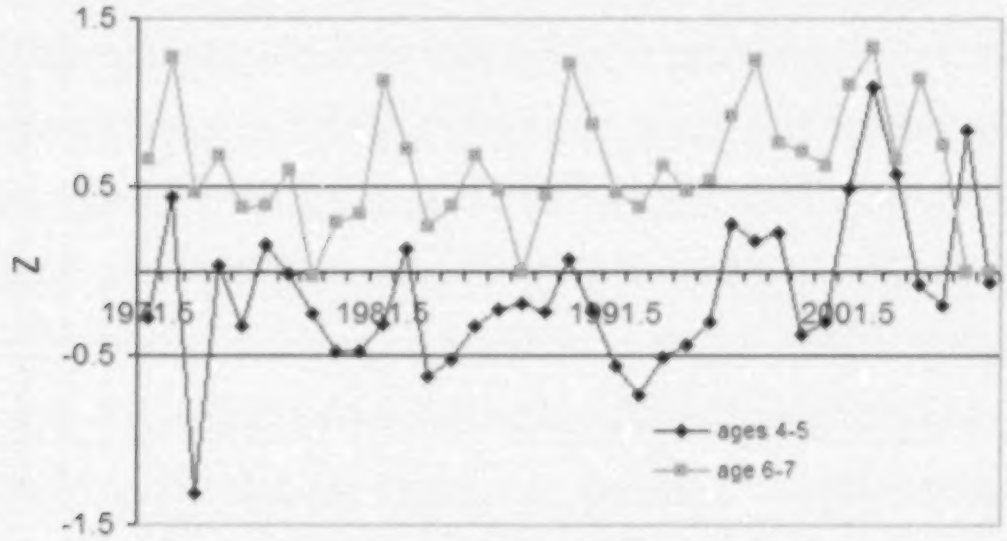

Figure 7. Estimates of total mortality (Z) by age class for NAFO Subdivision 4Vn (May-October) cod from the DFO summer RV survey.

Figure 8. Relative fishing mortality (F) for NAFO Subdivision 4Vn cod (May-October) from the DFO summer RV survey.

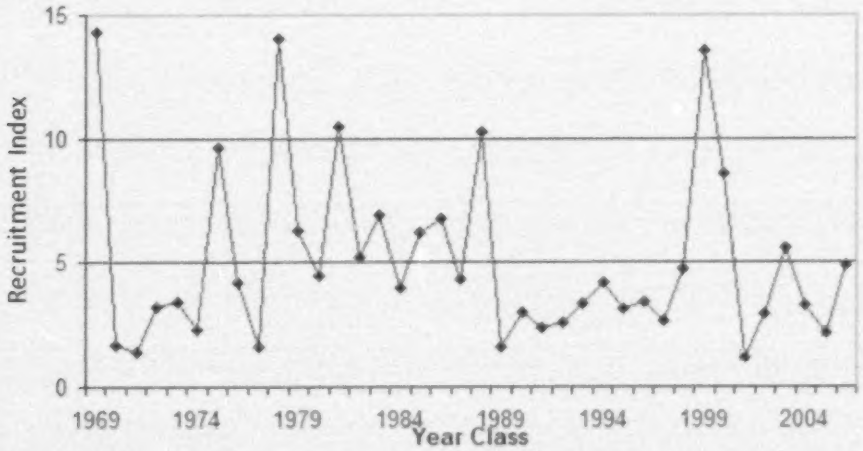

Figure 9a. Recruitment index of age 2-4 cohort numbers for NAFO Subdivision 4Vn cod (May-October) from the DFO summer RV survey.

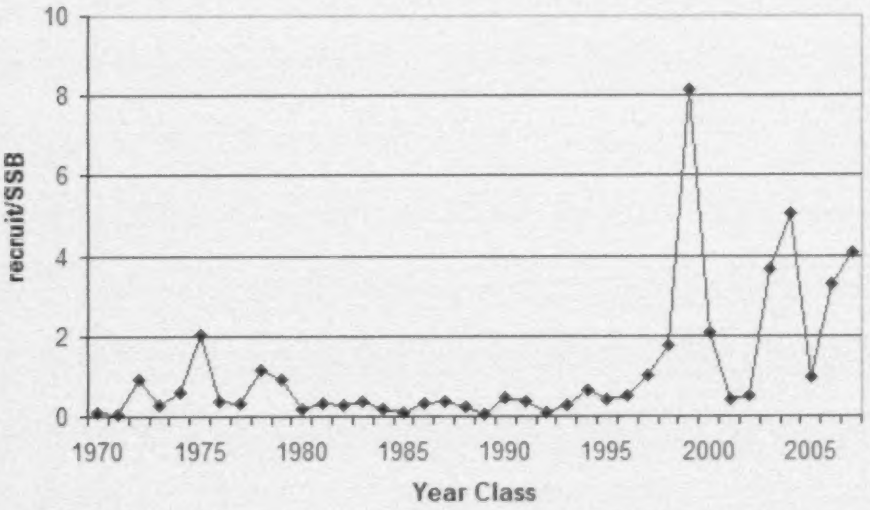

Figure 9b. Relationship between recruitment index (recruit) and spawning stock biomass (SSB) at age 5+ for NAFO Subdivision 4Vn cod (May-October) from the DFO summer RV survey.

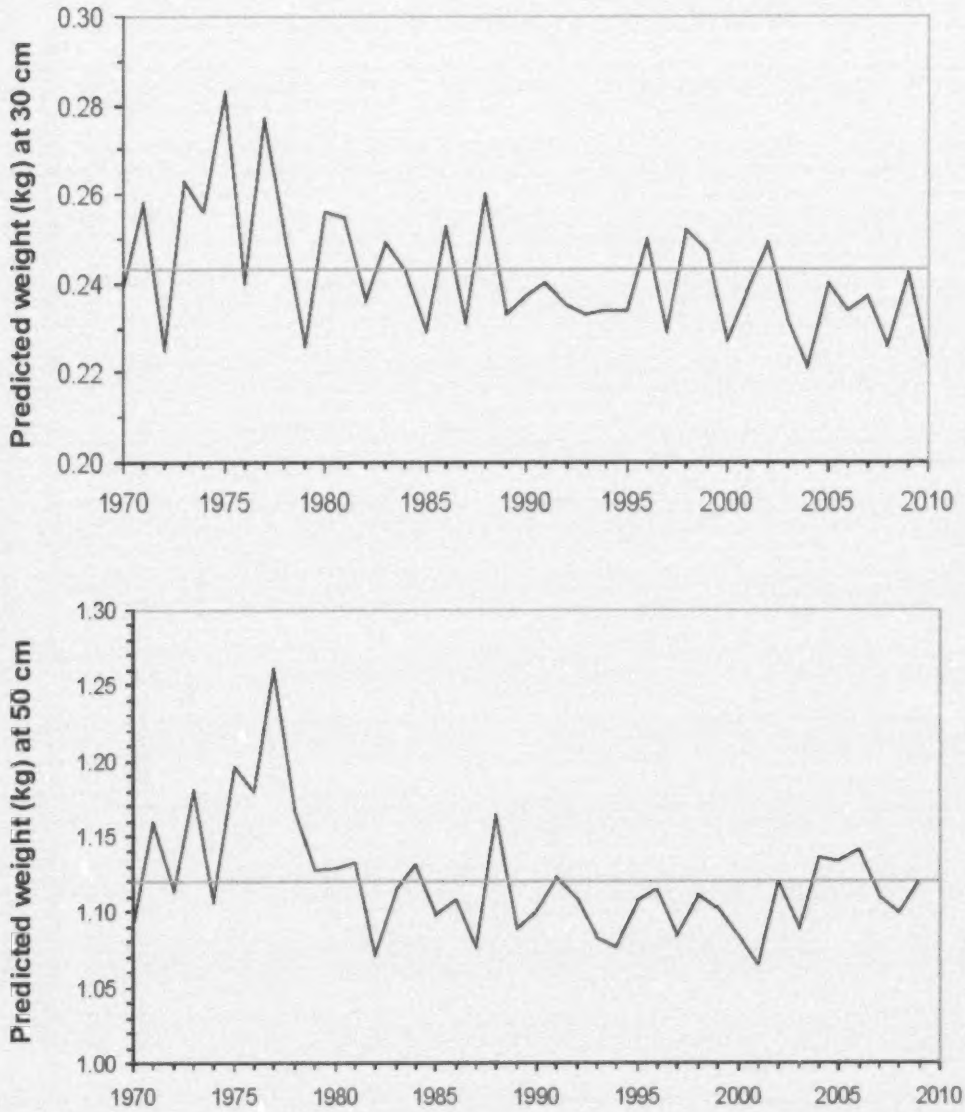

Figure 10. Condition (predicted weight at age) for 30 cm (top panel) and 50 cm (lower panel) NAFO Subdivision 4Vn (May-October) cod from the DFO summer RV survey. Horizontal line is the average from 1970-2009.

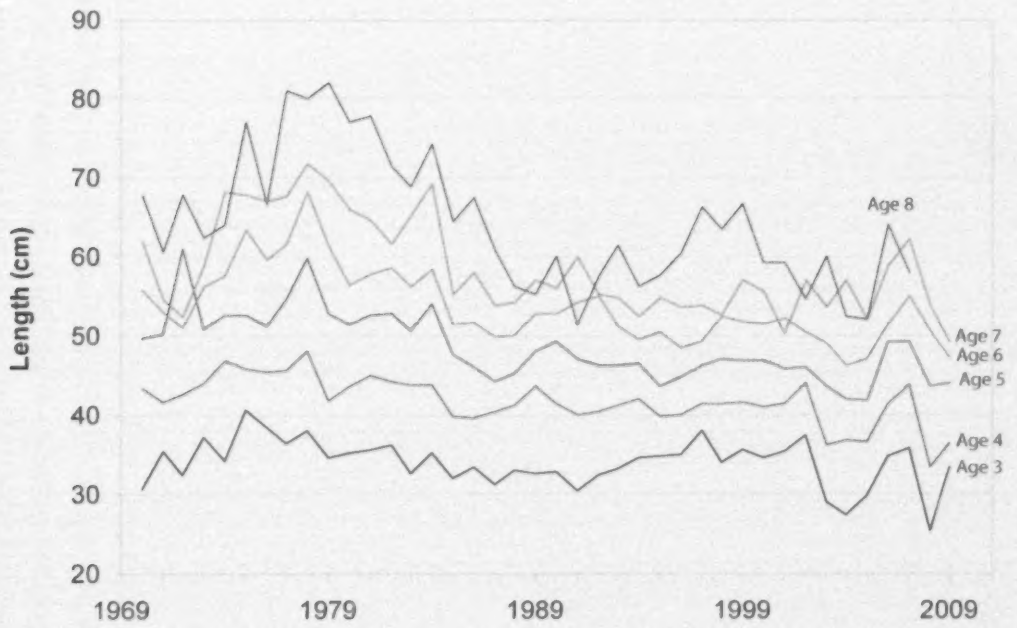

Figure 11. Length at age, for ages 3 to 8 years, for NAFO Subdivision 4Vn cod (May-October) from the DFO summer RV survey.

Figure 12. NAFO Subdivision 4Vn (May-October) estimated cod mature biomass (age 5+) from the DFO summer RV survey. The two horizontal lines represent the average of the time series for 1973-1978 and 2004-2009, respectively. The value reported in DFO (2011a, and 2011b) of 8,400 t for this similar calculation was for estimates not corrected for vessel effect in the 1973-1978 period. The conclusions of DFO (2011b) on status of the NAFO Subdivision 4Vn resident component and the potential for recovery are unchanged.